



U.S. AIR FORCE

Military Unique Applications for ADS-B

Headquarters U.S. Air Force ***USAF XOR-GANS***



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Military Unique Applications for ADS-B

Purpose

- Provide Background on Military ADS-B
- Discuss Potential Operational ADS-B Military Unique requirements
- Discuss Potential Military Applications for inclusion in DO-242A
- Discuss Potential Solutions



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Objective – Military will seek ADS-B capabilities which:

- **ENHANCE SAFETY**
- **ENHANCE MISSION**
- **OPEN MISSIONS** – e.g. Training, Channel, etc
- **“SENSITIVE”** – Missions in which the military may opt to inhibit or encrypt certain parameters e.g. *ADS-B listen only mode*
- **COVERT/CLASSIFIED** – ADS-B not applicable



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- **ENCRYPTION**
- **JAM/SPOOF RESISTANCE**

Not unique requirements to military. Other users may desire these features.



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Military Unique Applications for ADS-B

- **Air Refueling (AR)**
- **Formation Flying**
- **ADS-B & TCAS/ACAS**
- **Air Combat Maneuvering Instrumentation (ACMI)**
- **Drop Sondes – Wind Sondes**



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Air Refueling (AR) - Large Multi Engine Aircraft (Receivers)

Unique - Intentional proximity of aircraft

AR 101 Phases of Air Refueling

- Rendezvous *
- Closure*
- Contact
- Separation*

* = *Possible ADS-B applications*



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What does the receiver pilot need to know?

- **Relative Position of Tanker – (Range/Bearing)**
- **Relative Altitude of Tanker**
- **Relative Speed of Tanker**



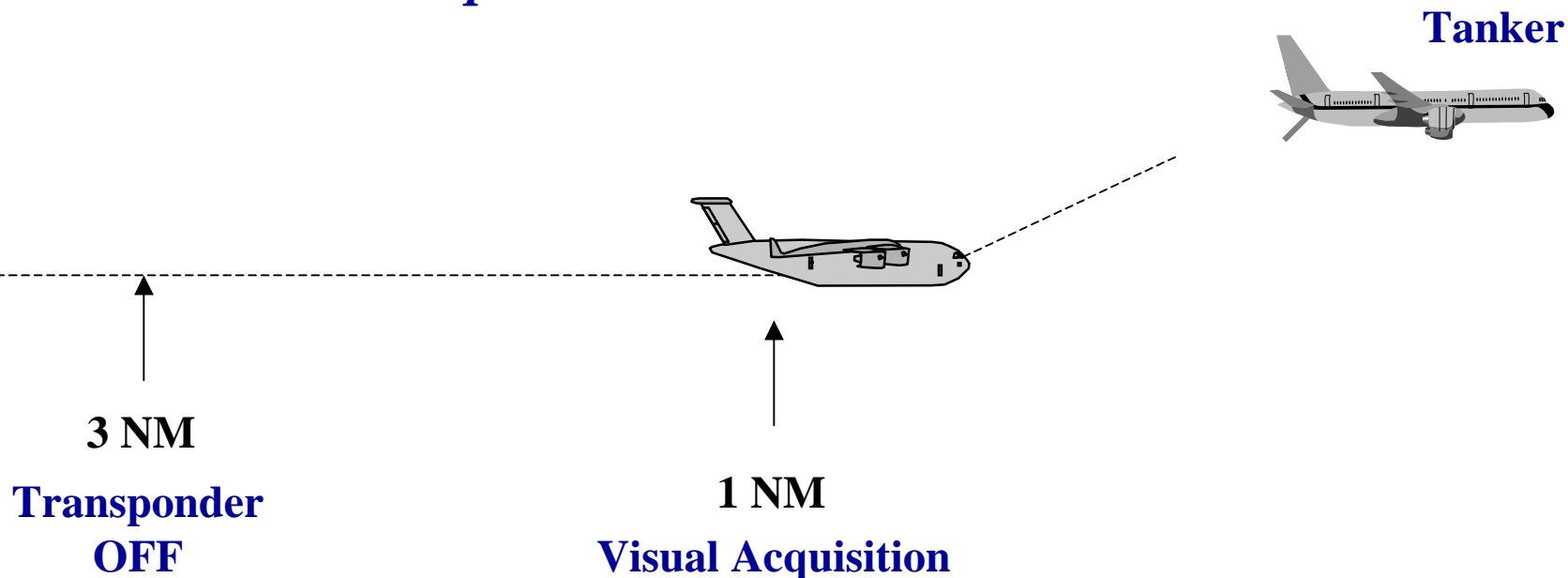
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RENDEZVOUS

- En route Pre-coordinated time, location, speed
- Point Parallel Tanker awaits receiver in holding (Anchor)

Rendezvous → “*Find the tanker*”
Position-Altitude-Speed





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Rendezvous → “*Find the tanker*”

- **Radar (Excellent fighter tool only)**
- **Radar Beacon**
- **TCAS/ACAS (ETCAS)**
- **UHF Direction Finding Hold Down**
- **ATC Radar**
- **Referenced Navigation Aids**

Position (range/bearing) – Altitude -- Speed

When visual:

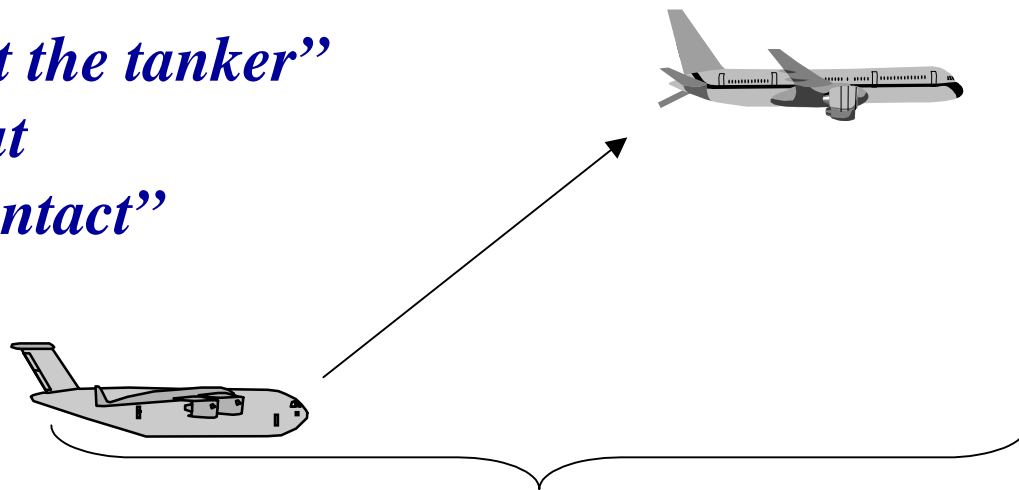
- **Lighting (at night)**



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CLOSURE – *“Don’t hit the tanker”*
but
“make contact”



Visual Acquisition to “Contact”

What the pilot needs – **POSITION (range)** – (ALTITUDE – SPEED)

- Range Information during final closure in meters, then feet **from boom**
 - “Up 1 ... back 3 ... stabilize”
 - (Boom extension range KC-135 is 6 to 18 ft)
- Requires information on navigational center of aircraft
- Meter accuracy in final closure



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SEPARATION

- Planned
- Emergency
- “Beak away”³



What the pilot needs

Position – Altitude - Speed



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IMC FORMATION FLYING

Unique – *Intentional Proximity of Aircraft*

- Large Multi-Engine Aircraft e.g. Hercules (C-130), C-17, KC-10
- IMC capability

Two Systems employed for Formation Station Keeping

- **RADAR**
 - “Coarse” Method
 - Aircraft Stacked Vertically
 - Relatively Large separation Distances
- **STATION KEEPING EQUIPMENT**
 - “Precise” Method
 - Co-Altitude
 - Relatively Close $\approx 4,000$ ft (1,200 meters)



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What does the receiver pilot need to know?

- **Deviation Information ... from assigned position**
- **Situational Awareness ... where are the other aircraft**
- **Proximity Warning**



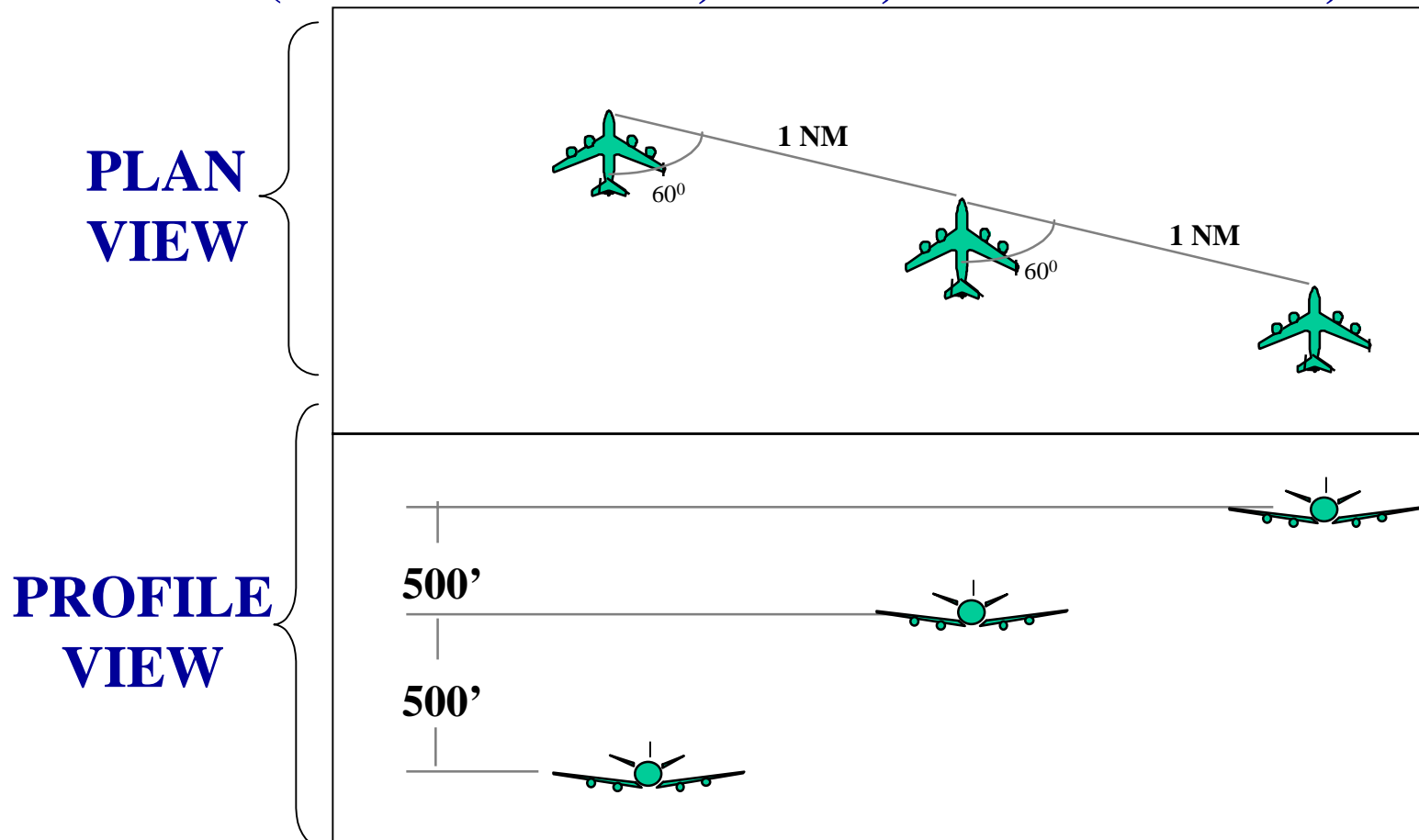
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FORMATION – RADAR

Large Multi Engine – A very coarse tool

(Climbs/Descents, Turns, account for TAS, etc)





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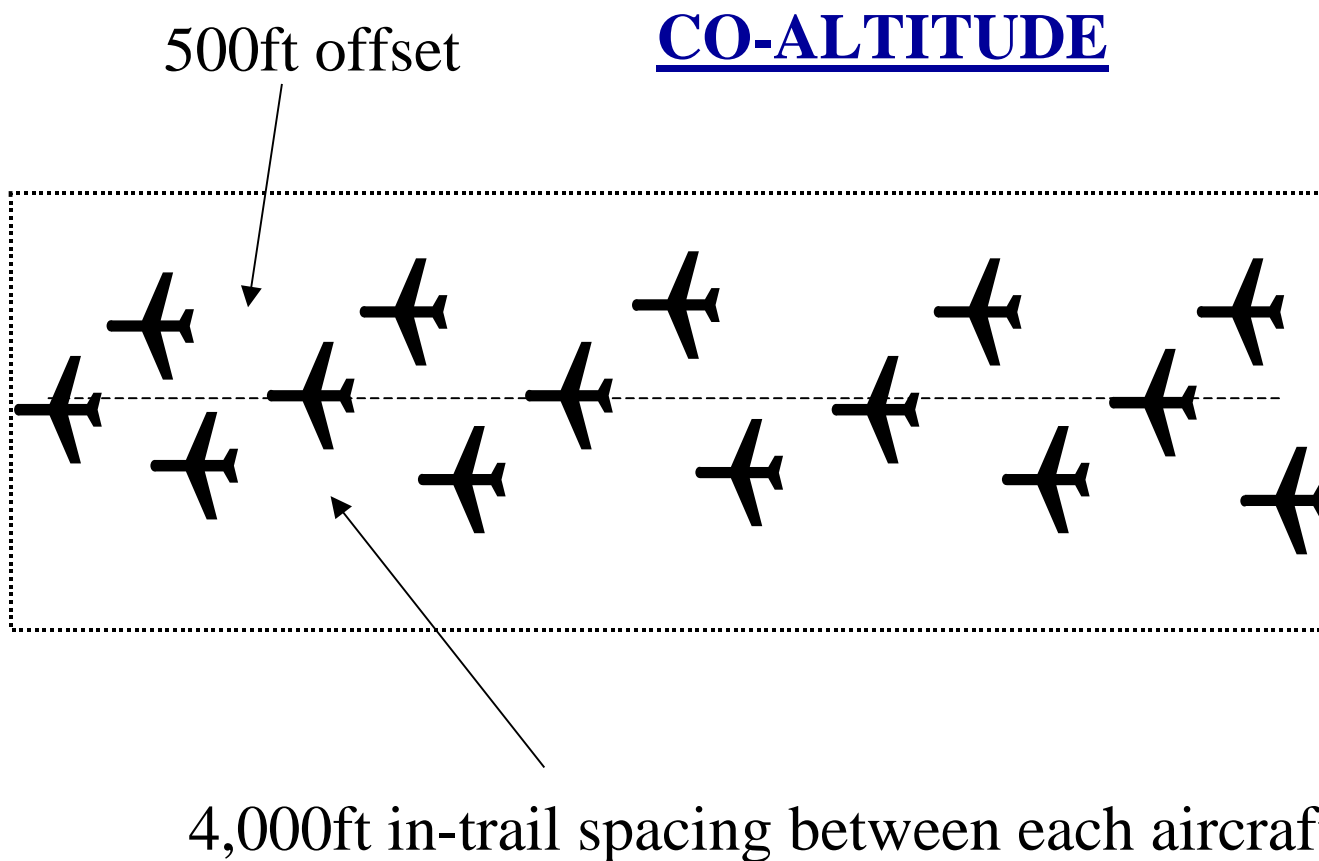




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SKE – Station Keeping Equipment (Datalink)





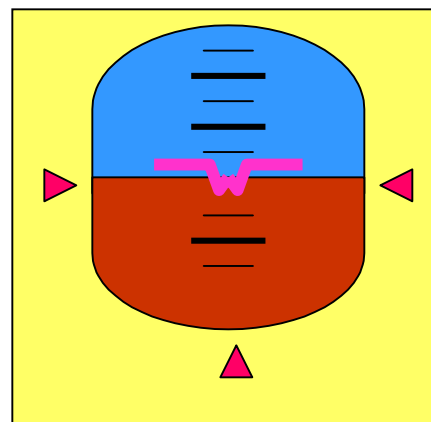
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SKE Station Keeping accomplished using:

Primary Flight Display

- Vertical Guidance
- Lateral Guidance
- Longitudinal Guidance



Navigation Display (Horizontal Situation Indicator)

- Station Keeping Guidance
- Situational Awareness

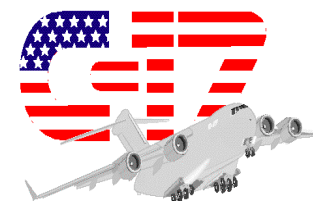
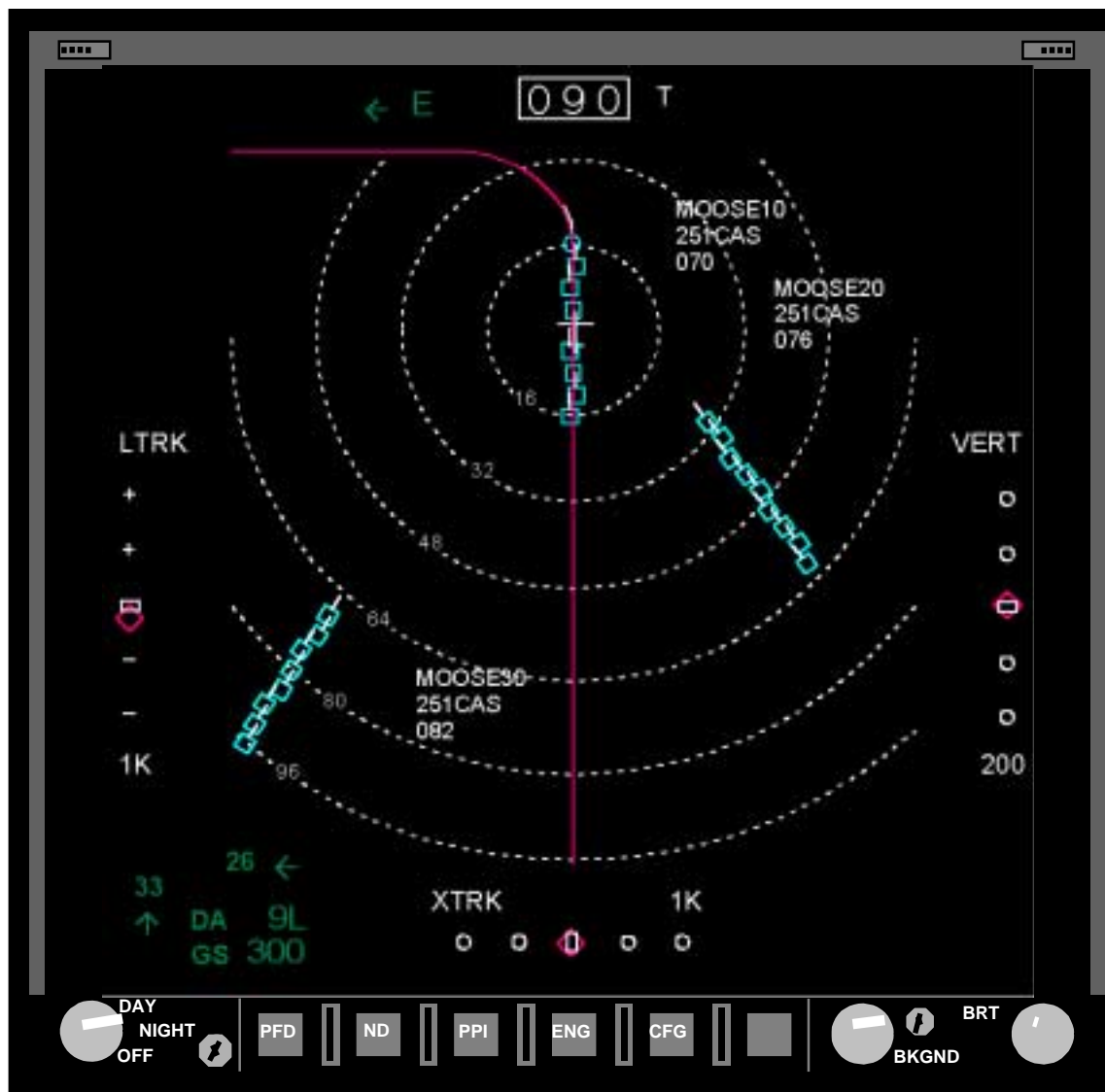
Proximity Warning System

- Aural warning on “intruder”



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SKE provides

- Deviation Information ... from assigned position
- Situational Awareness ... where are the other aircraft
- Proximity Warning

Radar does not provide above features

SKE

- Accounts for turn effects
- High update rate (>5 times/sec) - Integrity
- Datalinks additional information (text, preparatory signals, QNH, leads calculated winds for drops, etc)
- Autopilot Coupled or Manual



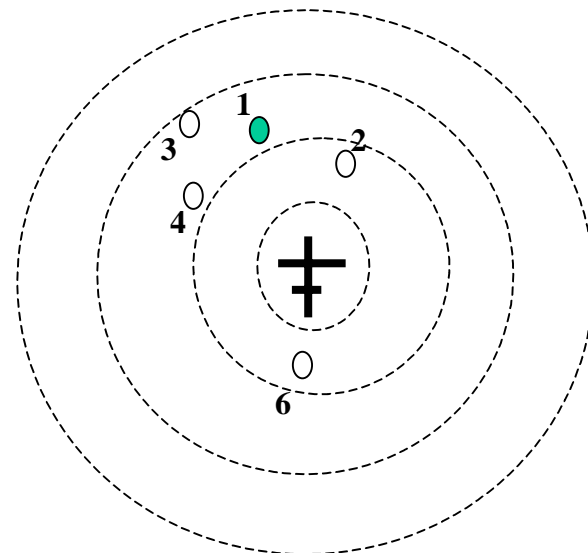
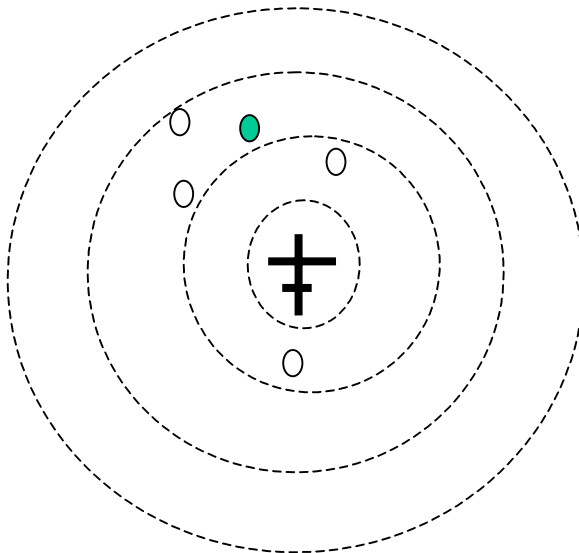
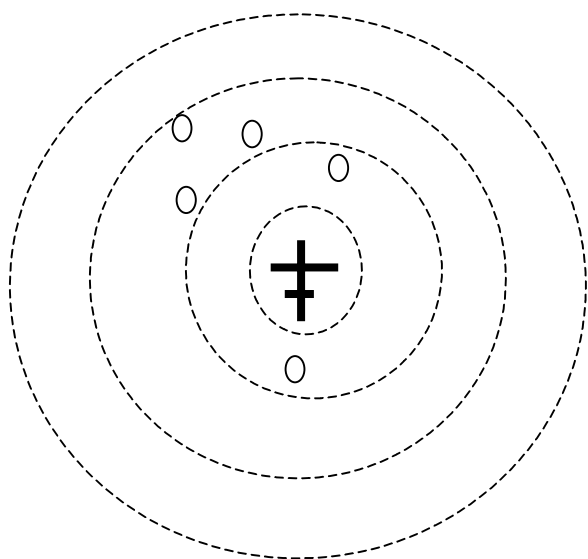
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Integration of ADS-B and formations

Intra-formation

- Broadcast rate? Additional parameters/message sets?
- Designated lead for flight ID?
- Wingmen slot# ?





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- Extra-formation

- One or multiple ADS-B signals from a formation?
 - *Conflicting “intent” messages from wingmen?*
- Designated intra formation message sets & broadcast
 - precludes unwanted/unnecessary broadcast to ATC system*
 - prevents ATC conflict alert*
- Different intra/extra formation broadcast rate
- Specify Formation Size/Geometry for other traffic
 - prevents multiple closely spaced & overlapping targets on civilian displays*

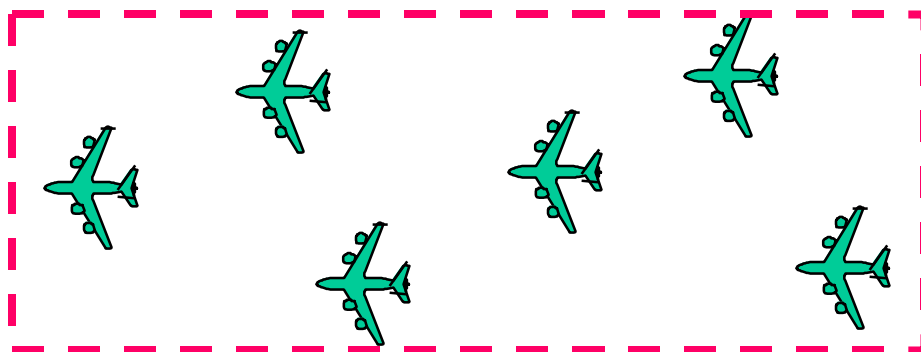


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ADS-B Formation – One or multiple broadcasts?

**ADS-B
Boundary**



4 NM

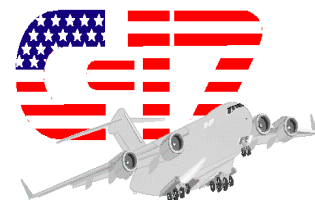
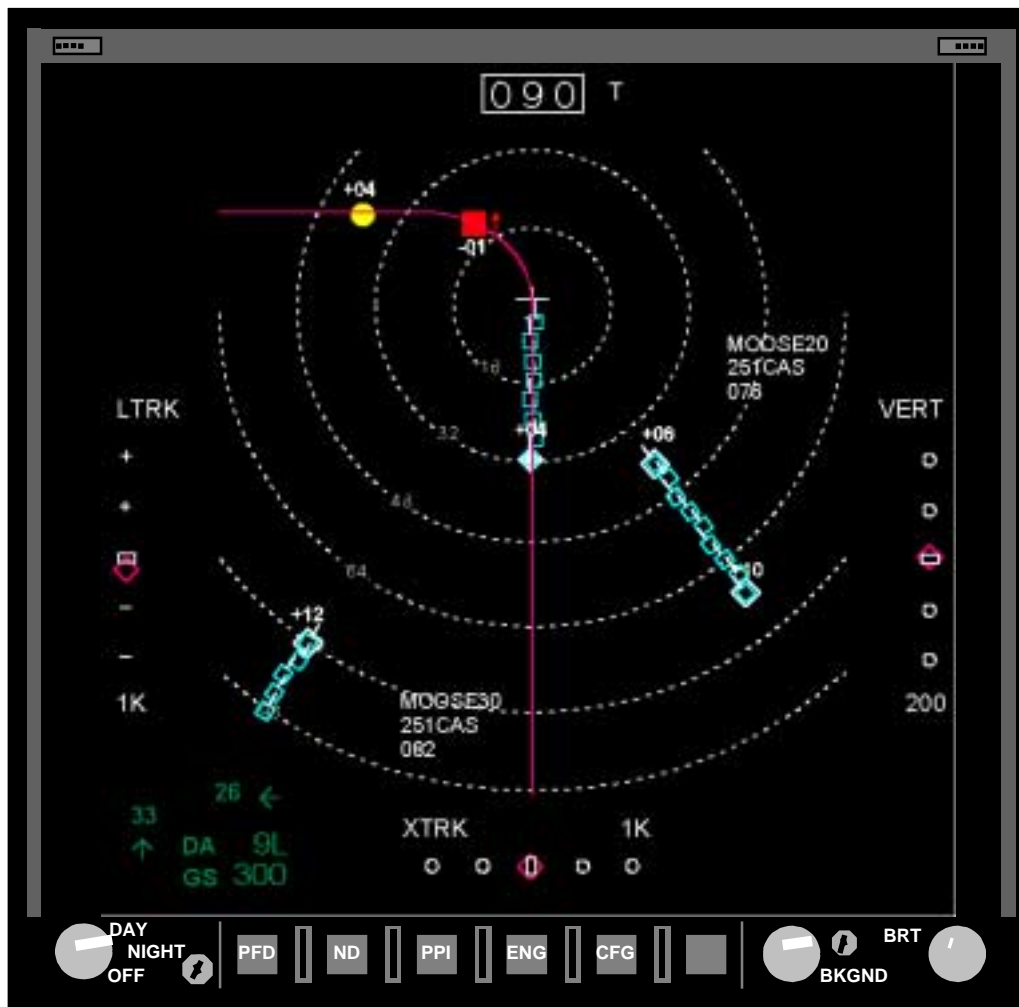
**SKE
FORMATION**



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TCAS limitations for formation



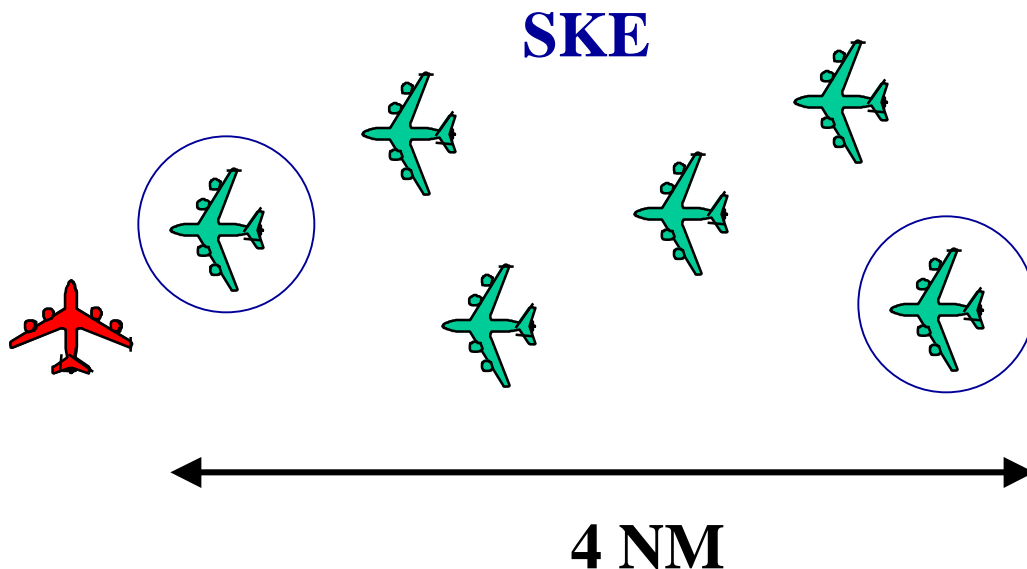


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TCAS in Formation

- Lead & Last Aircraft Squawk
- TCAS “single ship” product
- Ships 2 through 5 “blind”
- Lead in TA/RA?



- Lead follows RA
 - Wingmen leaderless
 - No TCAS guidance
 - No situational awareness
- Lead ignores RA
 - Safety implications

Can ADS-B help with its datalink capabilities for TCAS?



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Other possible military unique applications

- **ACMI Ranges**
- **Inexpensive Sondes (Airdrop wind gradients)**
- **Mission following (encryption)**